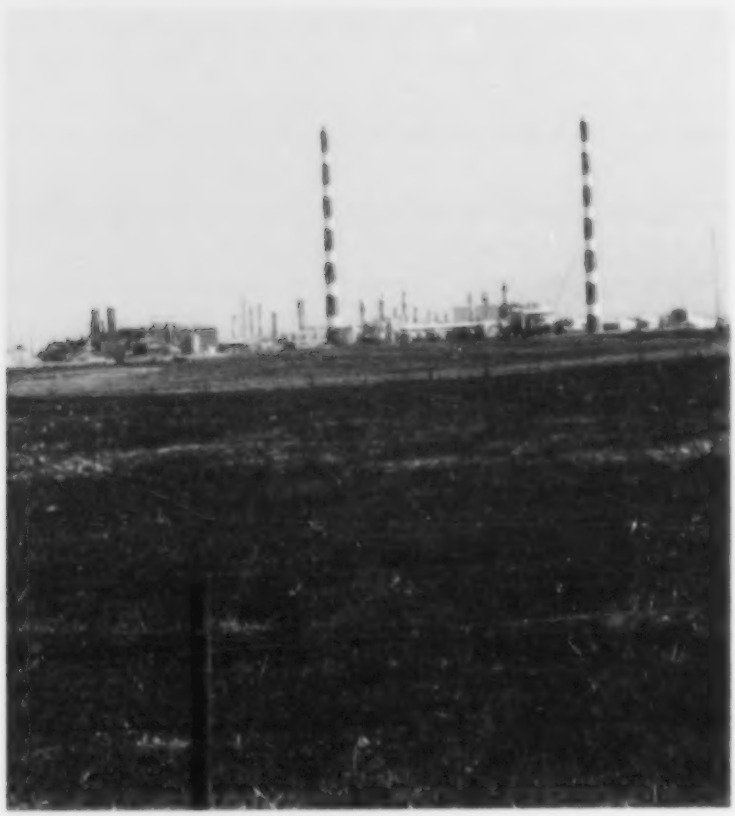
Statistical Series (ST) **101**

EUB

Sulphur Recovery and Sulphur Emissions at Alberta Sour Gas Plants

Annual Report for 2003

August 2004



Alberta Energy and Utilities Board

ALBERTA ENERGY AND UTILITIES BOARD
Statistical Series (ST) 101: Sulphur Recovery and Sulphur Emissions at Alberta Sour Gas Plants—Annual Report for 2003

August 2004

Published by
Alberta Energy and Utilities Board
640 – 5 Avenue SW
Calgary, Alberta
T2P 3G4

Telephone: (403) 297-8311
Fax: (403) 297-7040

Web site: <www.eub.gov.ab.ca>

105-02410/

Contents

1 Introduction 1

2 Summary of Performance for Grandfathered Plants, 2000-2003 2
2.1 Grandfathered Plants That Have Been Degrandfathered 2
2.2 Sulphur Emission Performance Credits (Emission Credits) 3
2.3 Sulphur Emissions and Inlets at Grandfathered Plants, 2000-2003 4
2.3.1 Sulphur Emission Reduction 4
2.3.2 Decline in Sulphur Inlet 5

3 Summary of Performance for Nongrandfathered Plants, 2000-2003 6

Appendix 1 Grandfathered and Nongrandfathered Sour Gas Plants 7
Appendix 2 Plants That Have Degrandfathered 11
Appendix 3 Sulphur Credits Earned 12
Appendix 4 Sulphur Plants with Sulphur Recovery 13

Figure 1 Net sulphur emission credits over time 3
Figure 2 Sulphur emissions from grandfathered plants 4
Figure 3 Sulphur inlet for grandfathered plants 5

1 Introduction

In *Interim Directive (ID) 2001-3: Sulphur Recovery Guidelines for the Province of Alberta*, the Alberta Energy and Utilities Board (EUB) committed to monitoring the sulphur recovery of grandfathered[1] sour gas plants and publishing an annual summary report on industry performance. This report covers both grandfathered sour gas plants (sulphur recovery and larger acid gas flaring sour gas plants) and nongrandfathered[2] gas plants (sulphur recovery and all acid gas injection sour gas plants). This is the second annual summary report following the implementation of *ID 2001-3*. A complete list of the grandfathered and nongrandfathered plants is in Appendix 1.

While *ID 2001-3* did not change the recovery levels expected for new gas plants, it set out clear expectations on when older grandfathered plants are required to meet the same requirements as new plants. The ID incorporates a phased approach to the more stringent requirements and encourages operators of sulphur recovery plants to take early action to improve performance.

Grandfathered sulphur recovery plants that perform better than the minimum requirements specified in *ID 2001-3* have the option to file sulphur emission performance credit report forms and may use the credits to meet a portion of the sulphur recovery requirements at a future date (i.e., operate for a longer time or at a higher inlet rate before having to degrandfather the plant). Most grandfathered sulphur recovery plants are now taking advantage of the emission credit program, and credits are continuing to grow every year.

Acid gas flaring plants have no ability to earn credits and are subject to more stringent requirements over time.

In the last four years a number of plants have degrandfathered:[3] 8 plants have made upgrades to their plant, 3 plants have relicensed to meet the requirements for new plants, and 4 plants have been shut down. In addition, sulphur emissions have decreased substantially for both grandfathered acid gas flaring plants (emissions down 30 per cent) and grandfathered sulphur recovery plants (emissions down 25 per cent).

---

[1] Grandfathered plants are those that do not meet the sulphur recovery requirements for new plants listed in *ID 2001-3*. This includes some sulphur recovery plants and larger (sulphur inlet greater than 1 tonne per day [t/d]) acid gas flaring plants.

[2] Nongrandfathered plants are those with an approved sulphur inlet greater than 1 t/d meeting the requirements for new plants, as listed in *ID 2001-3*. This includes some sulphur recovery plants and all acid gas injection plants.

[3] Degrandfathered plants are those that did not previously meet the requirements of *ID 2001-3* for new plants but have now relicensed to meet the requirements for new plants as set out in the ID.

2 Summary of Performance for Grandfathered Plants, 2000-2003

2.1 Grandfathered Plants That Have Been Degrandfathered

In the last four years, 8 plants have made modifications to improve or install sulphur recovery at their plants to meet the more stringent sulphur recovery requirements for new plants. In addition, 3 other plants have been relicensed to meet these more stringent sulphur recovery requirements, and 4 grandfathered plants have shut down.

Plants making modifications to meet the requirements for new plants

Plant name	Operator
1. Brazeau River	KeySpan
2. Garrington (Olds)	Esprit
3. Homeglen (Rimbey)	KeySpan
4. Bantry	AltaGas
5. Vulcan (Long Coulee)	Conoco Phillips
6. Wilson Creek	Petro-Canada
7. Rainbow	Husky
8. Edson	Talisman

The 8 operators listed above made significant physical modifications to their plants to achieve higher sulphur recoveries.

Plants relicensing to meet the requirements for new plants

Plant name	Operator
1. Okotoks (Mazeppa)	Mazeppa Processing
2. Crossfield East	PrimeWest
3. Sylvan Lake	NAL Resources

Of the 3 plants listed above, 2 were relicensed to a higher sulphur recovery efficiency with existing equipment and 1 was relicensed to a lower throughput.

Grandfathered plants that have shut down

Plant name	Operator
1. North Rosevear	Suncor
2. Bittern Lake	CNRL
3. North Caroline	BP Canada
4. South Caroline	BP Canada

A detailed list of plants that have been degrandfathered in the last four years is in Appendix 2, along with the process used for improving the sulphur recovery.

As of July 2004, there are 22 grandfathered sulphur recovery plants and 22 grandfathered acid gas flaring plants remaining (see Appendix 1).

2.2 Sulphur Emission Performance Credits (Emission Credits)

Emission credits can be earned by grandfathered sour gas plants with sulphur recovery that achieve recovery efficiencies higher than their required blended sulphur recovery efficiency. Credits cannot be transferred between facilities and do not apply to acid gas flaring plants.

Credit reports can help an operator

- operate at higher sulphur inlets,
- meet the required blended sulphur recovery efficiency, and
- defer upgrading for a longer period of time.

In order to earn credits, a credit report must be filed on time at the end of each quarter. The filing of credit reports is optional, but once an initial credit report is filed, the operator must continue to file them. Reports may not be filed retroactively.

Each sulphur emission credit represents 1 tonne (t) of sulphur emissions that would have been emitted if the plant exactly met its minimum requirement. Credits must be earned before they can be used.

Most plants that are able to file credit reports are doing so, and the emission credits are growing, as one would expect in this initial period. As of the end of the fourth quarter of 2003, over 30 000 t of sulphur emission credits had been earned (see Figure 1). The total sulphur emissions from grandfathered sulphur recovery plants in 2003 was only 43 000 t, i.e., emission credits earned in the last 2 years equate to about 8 months of emissions from the grandfathered sulphur recovery plants.

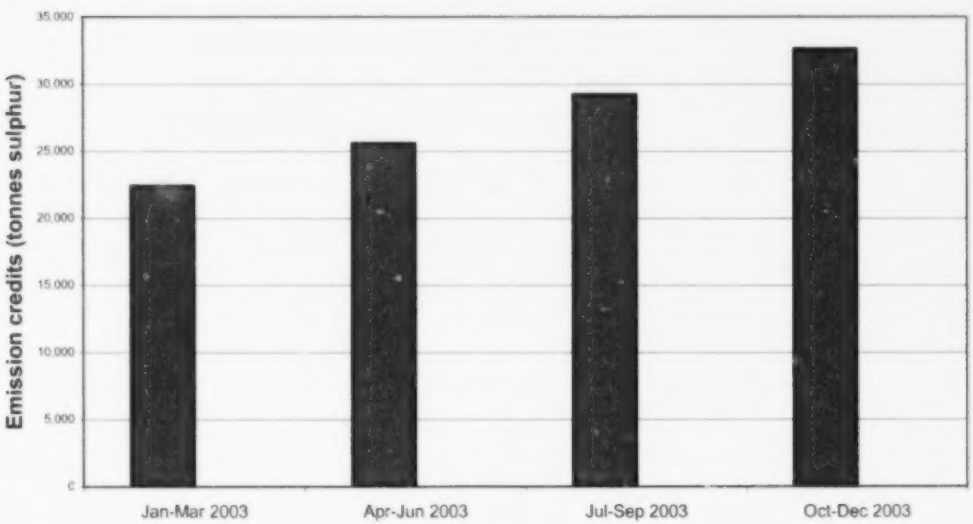


Figure 1. Net sulphur emission credits over time

Appendix 3 lists cumulative credits for each of the grandfathered sulphur recovery plants in 2003.

2.3 Sulphur Emissions and Inlets at Grandfathered Plants, 2000-2003

An analysis of the sulphur emissions and sulphur inlet for the specific plants that were listed in *ID 2001-3* as grandfathered follows in Sections 2.3.1 and 2.3.2. For the purpose of this analysis, plants that have degrandfathered since the ID was issued are included with the grandfathered plants.

2.3.1 Sulphur Emission Reduction

There have been substantial reductions in sulphur emissions from the grandfathered plants between 2000 and 2003, as shown in Figure 2.

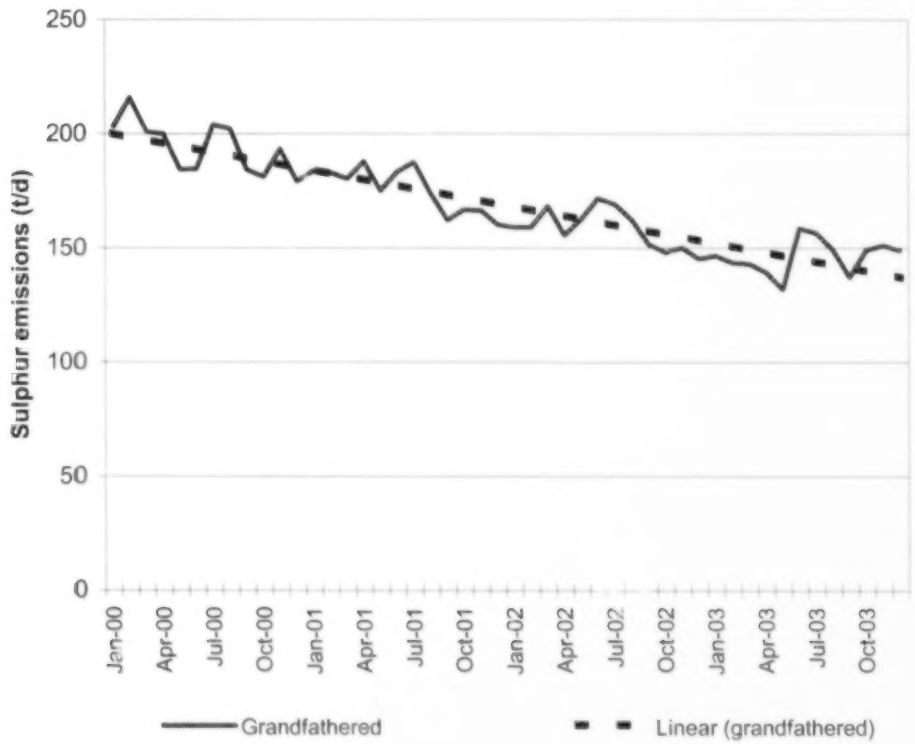


Figure 2. Sulphur emissions from grandfathered plants

The drop in emissions from grandfathered plants shown in Figure 2 is due to a decrease of about 30 per cent in emissions from the grandfathered acid gas flaring plants and a decrease of about 25 per cent from the grandfathered sulphur recovery plants between 2000 and 2003.

Of the 30 per cent decrease in emissions from grandfathered acid gas flaring plants from 2000 to 2003, about 20 per cent is due to declining sulphur inlet. The other 10 per cent is due in large part to the acid gas injection facility installed at ConocoPhillips Vulcan and the installation of sulphur recovery at PetroCanada Wilson Creek. Between 2000 and 2003, 23 of the 28 grandfathered acid gas flaring plants showed emission reductions.

Similarly, of the 25 per cent decrease in emissions from grandfathered sulphur recovery facilities from 2000 to 2003, about 20 per cent is due to declining sulphur inlet. The other 5 per cent decrease in emissions is due in large part to improved operations at BP Windfall, Husky Ram River, and Shell Jumping Pound and the installation of acid gas injection at KeySpan Brazeau. Between 2000 and 2003, 25 of the 28 grandfathered sulphur recovery plants reduced emissions, as shown in Appendix 4.

Appendix 4 lists sulphur production and emissions for each of the sulphur recovery plants for the years 2000 and 2003.

2.3.2 Decline in Sulphur Inlet

While improvements in operation have played a role in emission reductions at the grandfathered plants, as noted in the previous section, the reduction is also due to the declining sulphur inlets of these plants.

Figure 3 shows the decline in sulphur inlets for grandfathered gas plants.

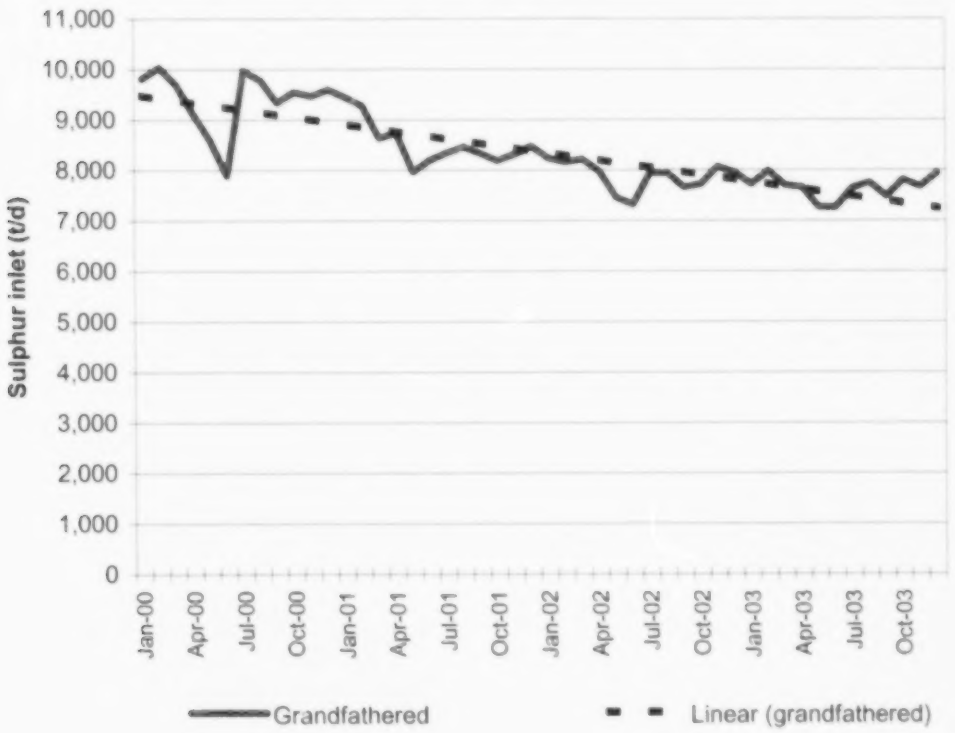


Figure 3. Sulphur inlet for grandfathered plants

3 Summary of Performance for Nongrandfathered Plants, 2000-2003

The sulphur emissions and sulphur inlet for the specific sour gas plants (having a sulphur inlet greater than 1 t/d) that met the requirements for new plants when *ID 2001-3* was issued were also examined.

The drop in sulphur emissions from these plants was about 20 per cent between 2000 and 2003. A smaller reduction in sulphur inlet, about 2 per cent, occurred over the same period. Details on these reductions on an individual plant basis for plants with sulphur recovery are given in Appendix 4.

Appendix 1.1. Grandfathered and Nongrandfathered Sour Gas Plants - Grandfathered Sulphur Recovery Gas Plants

		Plant Code	Current Approved Sulphur Recovery Efficiency (%)	Guideline Recovery for Approved Sulphur Inlet (%)	Daily Approved S Inlet (t/d)	Baseline Capacity 1999 S Inlet (t/d)	Change in Status (from *ID 2001-3*)
1	Brazeau R. - KeySpan**	1108	98.4	98.4%	400.0	67.3	Degrandfathered in 2003 became AGI
2	Brazeau R. (Nordegg) - KeySpan	1121	93.5	95.9%	49.8	38.2	
3	Burnt Timber - Shell	1131	96.5	98.4%	560.0	412.4	
4	Caroline (North) 1-11 - BP Canada	1374	69.7	69.7%	5.0	5.0	Plant shut down in 2003
5	Caroline (South) 4-20 - BP Canada	1104	85.0	89.7%	9.8	6.8	Plant shut down in 2003
6	Carstairs - Bonavista	1020	90.0	98.2%	72.2*	9.5	
7	Crossfield (Balzac) - Nexen	1050	98.0	98.5%	1,730.1	414.6	
8	Edson - Talisman	1084	98.4	98.4%	350.0	220.9	Degrandfathered in 2003; upgraded SR
9	Gold Creek - CNRL	1129	97.0	98.3%	100.0	64.1	
10	Jumping Pound - Shell	1037	96.2	98.4%	619.0	472.1	
11	Kaybob S. 1 & 2 - BP Canada	1107	98.4	98.5%	1,107.7	540.6	
12	Kaybob S. 3 - Chevron	1144	98.1	99.5%	3,629.7	1,009.6	
13	Lone Pine Ck. - ExxonMobil	1139	98.0	98.3%	165.4	129.5	
14	Minnehik B. L. - Penn West	1047	95.6	95.9%	49.2	22.0	
15	Okotoks (Mazeppa) - Mazeppa Processing	1530	98.4	98.4%	586.6	263.4	Degrandfathered in 2002
16	Redwater - Imperial	1028	Fluctuating	95.9%	12.2*	3.1	
17	Rosevear (North) - Suncor	1206					Plant shut down in 2001
18	Rosevear (South) - Suncor	1268	95.6	98.3%	171.0	76.0	Plant consolidation 1206
19	Simonette - Suncor	1113	96.5	98.3%	120.0	92.3	
20	Strachan (Ram River) - Husky	1141	98.1	99.5%	4,660.5*	2,301.8	
21	Strachan - KeySpan	1133	98.1	98.4%	971.1	264.9	
22	Sturgeon Lk. - Chariot	1112	94.0	98.3%	104.2	40.6	
23	Teepee -Talisman	1296	92.0	95.9%	25.0	17.5	
24	Waterton - Shell	1056	98.7	99.5%	3,148.0	2,099.6	
25	Wildcat Hills - Petro-Canada	1054	97.5	98.3%	287.5	181.3	
26	Wimborne - Devon	1081	95.5	98.3%	235.0	182.1	
27	Windfall (West Whitecourt) - BP Canada	1034	98.3	98.5%	1,356.1	777.6	
28	Zama - Apache	1219	92.0	98.2%	80.3	38.6	Baseline revision 2001

* Annual average sulphur inlet.

** KeySpan Brazeau River became an AGI facility in 2003. Injected volumes in 2003 were 134.4 t/d.

Appendix 1.2. Grandfathered and Nongrandfathered Sour Gas Plants - Grandfathered Acid Gas Flaring Plants

		Plant Code	Guideline Recovery for Approved Sulphur Inlet (%)	2003 S Emissions (t/d)	Approved S Inlet (t/d)	Baseline Capacity 1999 S Inlet (t/d)	Changed Status (from *ID 2001-3*)
1	Ansell (Galloway) - CNRL	1417	69.7	0.40	1.40	1.3	
2	Bantry - AltaGas	1114	69.7	0.59	2.00	1.0	Degrandfathered in 2002; became SR
3	Bellshill Lake - Viking Energy	1280	89.7	2.42	5.77	3.8	
4	Big Bend - CNRL	1293	69.7	0.16	1.46	1.0	
5	Bigoray - PennWest	1138	69.7	0.81	2.96	1.8	
6	Bittern Lake - CNRL	1124	69.7	0.00	2.48	1.0	Plant shut down in 2000
7	Boundary Lake S - PennWest	1202	69.7	1.09	2.20	1.1	
8	Boundary Lake S - Talisman	1024	69.7	0.76	1.90	1.0	
9	Carson Creek - ExxonMobil	1062	69.7	0.27	1.00	1.0	
10	Enchant - Taylor Management	1039	69.7	0.14	1.25	1.0	
11	Forestburg - Signalta	1365	69.7	1.20	4.50	4.0	
12	Greencourt - CNRL	1127	89.7	1.04	5.08	1.3	
13	Harmattan-Elkton - Bonavista	1083	69.7	0.25	1.60	1.0	
14	Judy Creek - Pengrowth	1069	69.7	2.20	3.60	2.7	
15	Kaybob - Paramount	1058	89.7	1.21	5.15	1.0	
16	Killam (Sedgewick) - AltaGas	1510	69.7	1.40	4.75	2.2	
17	Leduc - Woodbend - Imperial	1023	69.7	0.02	1.01	1.0	
18	Little Bow (Travers) - ConocoPhillips	1150	69.7	0.79	1.60	1.2	
19	Retlaw (Turin) - Taylor Management	1191	69.7	1.69	2.40	1.7	
20	Spirit River - Bonavista	1560	69.7	0.63	2.60	1.0	
21	Strome - CNRL	1179	69.7	0.60	3.40	1.6	
22	Sylvan Lake - NAL Resources	1070	0	0.33	0.75	1.0	Degrandfathered in 2002
23	Virginia Hills (Hope Creek) - Apache	1135	89.7	6.02	9.80	5.2	
24	Vulcan - (Long Coulee) ConocoPhillips*	1100	69.7	0.03	4.90	2.7	Degrandfathered in 2002; became AGI
25	West Drumheller - Acclaim	1109	69.7	0.32	2.99	1.1	
26	Whitecourt - Shining Bank	1115	89.7	3.16	7.50	3.5	
27	Wilson Creek - Imperial	1399	69.7	0.18	1.68	1.0	
28	Wilson Creek - Petro-Canada	1096	69.7	0.12	4.70	2.3	Degrandfathered in 2001; became SR

* ConocoPhillips Vulcan injected volumes in 2003 were 2.10 t/d.

Appendix 1.3. Grandfathered and Nongrandfathered Sour Gas Plants - Nongrandfathered Sulphur Recovery Plants

		Plant Code	Current Approved Sulphur Recovery Efficiency (%)	Approved S Inlet (t/d)
1	Basing (Hanlan Robb) - Petro-Canada	1360	98.5	1,270.0
2	Bonnie Glen - Imperial	1045	95.9	35.6
3	Brazeau R. - Petro-Canada	1482	98.4	455.0*
4	Brazeau R. (West Pembina) - Atco Midstream	1458	98.4	526.8
5	Campbell-Namao (Carbondale) - Atco Midstream	1638	69.7	1.15*
6	Caroline - Shell	1662	99.5	5,450.0
7	Crossfield E. - Primewest	1079	98.4	863.8
8	Garrington (Olds) - Esprit	1021	98.4	404.9
9	Harmattan - Solex	1060	98.6	82.7
10	Hays - Anadarko	1585	90.0	9.9
11	Homeglen Rimbey - KeySpan	1004	98.3	150.0
12	Nevis - Duke Energy	1002	98.4	300.0
13	Progress - Anadarko	1506	96.5	49.5
14	Progress - Suncor	1629	69.7	2.5
15	Quirk Ck. - Imperial	1134	98.3	306.4*
16	Rainbow - Husky**	1105	98.3	213.5
17	Rainbow - Gibson	1658	95.9	23.18
18	Saddle Hills (LaGlace) - EnCana	1892	98.4	483.1
19	Savanna Ck. (Coleman) - Northstar	1051	98.6	800.0
20	Sinclair (Hythe Brainard) - EnCana	1147	98.3	132.2
21	Swalwell - Viking Energy	1654	70.0	4.6

* Annual average sulphur inlet.

** Husky Rainbow became an AGI facility in Jan/02. Injected volumes were 103.1 t/d for 2003.

Appendix 1.4. Grandfathered and Nongrandfathered Sour Gas Plants - Nongrandfathered Acid Gas Injection Plants

	Nongrandfathered Acid Gas Injection Plants	Plant Code	Sulphur Recovery Equivalent Required (%)	Approved S Inlet (t/d)	2003 S Emissions (t/d)	2003 Sulphur Injected (t/d)
1	Acheson - EnerPro Midstream	1628	69.7	4.65	0.01	0.96
2	Bistcho Lk - Paramount	1975	95.9	25.00	0.09	14.13
3	Bigoray - EnerPro Midstream	1357	98.2	64.00	0.32	14.67
4	Boundary Lk S (Clear Hills) - CNRL	1880	95.9	15.35	0.02	7.46
5	Dizzy (Steen River) Penn West	1738	95.9	34.40	0.02	5.91
6	Dunvegan - Devon	1169	89.7	9.90	0.01	0.66
7	Eaglesham - (West Culp) Devon	1775	95.9	17.20	0.02	1.65
8	Galahad - Husky	1690	89.7	7.54	0.01	2.89
9	Golden Spike - Atco Midstream	1547	95.9	26.46	0.01	3.75
10	Gordondale - Duke	1668	98.2	54.30	0.07	21.20
11	Kelsey (Rosalind) - Thunder	1244	69.7	2.50	0.01	1.34
12	Leduc-Woodbend (Calmar) - Midcoast Canada	1676	95.9	15.54	0.01	2.56
13	Marlowe (Dizzy) - Bearspaw	1765	95.9	19.70	0.00	1.12
14	Mulligan (Fourth Creek) - Duke	1895	89.7	10.00	0.01	7.29
15	Normandville - Devon	1990	69.7	1.90	0.00	0.08
16	O'Chiese - Burlington	1970	95.9	14.53	0.01	0.48
17	Paddle River - KeySpan	1089	69.7	1.50	0.01	0.81
18	Pembina - EnerPro Midstream	1402	95.9	29.70*	0.05	4.68
19	Pembina - Imperial	1625	69.7	4.20	0.03	1.93
20	Pouce Coupe - Duke	1746	95.9	26.20	0.09	9.25
21	Provost (Hansman Lk) - Husky	1698	89.7	10.00	0.08	4.30
22	Provost (Thompson Lk) - Husky	1695	95.9	12.00	0.12	5.64
23	Puskwaskau - Devon	1964	89.7	5.15	0.04	0.34
24	Rainbow - ExxonMobil	1155	95.9	20.10*	0.33	11.05
25	Rainbow - Husky	1105	98.3	213.49	0.29	103.07
26	Rycroft - Devon	1793	95.9	21.00	0.02	6.65
27	Watelet (Glen Park) - Atco	1672	69.7	3.30	0.01	0.64
28	Wayne-Rosedale - EnCana	1888	89.7	5.90*	0.04	1.82
29	Wembley - ConocoPhillips	1520	98.3	124.00	0.09	49.27
30	Zama - Apache	1878&1978	98.3	247.00	0.05	34.42

* Annual average sulphur inlet.

Appendix 2. Plants That Have Degrandfathered

		Plant Code	Plant Name	Approved S Inlet max daily (t/d)	Modification Process
Seven plants modified					
1	Plant Mods	1108	Brazeau R. - KeySpan	400.00	(agi)
2	Plant Mods	1021	Garrington (Olds) - Esprit	404.90	(SuperClaus)
3	Plant Mods	1004	Homeglen Rimbey - KeySpan	150.00	(SuperClaus)
4	Plant Mods	1114	Bantry - AltaGas	2.00	(Xergy)
5	Plant Mods	1100	Vulcan (Long Coulee) - ConocoPhillips	4.90	(agi)
6	Plant Mods	1096	Wilson Creek - Petro-Canada	4.70	(Claus)
7	Plant Mods	1105	Rainbow - Husky	213.50	(agi)
8	Plant Mods	1084	Edson - Talisman	350.00	(Superclaus)
Three plants relicensed to higher S recovery efficiency or lower sulphur inlets					
9	Relicensed	1530	Okotoks (Mazeppa) - Mazeppa Processing	586.60	
10	Relicensed	1079	Crossfield E. - Primewest	863.80	
11	Relicensed	1070	Sylvan Lake - NAL Resources	0.75	
Other - Sulphur recovery not required, given the low approved sulphur inlet					
	Plant Mods	1739	Bantry - EnCana	0.92	(Shell Paques/New Paradigm)

Appendix 3. Sulphur Credits Earned

		Grandfathered Sulphur Recovery Gas Plants	Credits				Cummulative Credits				
			Jan-Mar 2003	Apr-Jun 2003	Jul-Sep 2003	Oct-Dec 2003	Jan-Mar 2003	Apr-Jun 2003	Jul-Sep 2003	Oct-Dec 2003	Status
	Plant Code										
1	1108	Brazeau R. - KeySpan	-	-	-	-	-	-	-	-	Degrandfathered
2	1121	Brazeau R. (Nordegg) - KeySpan	0.0	65.5	51.1	6.0	262.4	327.9	379.0	385.0	
3	1131	Burnt Timber - Shell	59.2	58.9	209.5	53.0	593.1	652.0	861.5	914.5	
4	1374	Caroline (North) 1-11 - BP Canada	-	-	-	-	-	-	-	-	Plant shut down
5	1104	Caroline (South) 4-20 - BP Canada	-	-	-	-	-	-	-	-	Plant shut down
6	1020	Carstairs - Bonavista	14.6	11.9	14.5	12.8	101.5	113.4	127.9	140.7	
7	1050	Crossfield (Balzac) - Nexen	202.9	172.8	72.3	77.7	878.6	1,051.4	1,123.7	1,201.4	
8	1084	Edson - Talisman	14.8	-	-	-	122.2	122.2	122.2	122.2	Degrandfathered
9	1129	Gold Creek - CNRL	-	-	-	-	-	-	-	-	
10	1037	Jumping Pound - Shell	242.1	25.0	173.6	282.0	1,119.6	1,144.6	1,318.2	1,600.2	
11	1107	Kaybob S. 1 & 2 - BP Canada	210.1	77.0	148.9	117.4	1,316.8	1,393.8	1,542.7	1,660.1	
12	1144	Kaybob S. 3 - Chevron	336.9	0.0	263.8	-181.9	1,056.1	1,056.1	1,319.9	1,138.0	
13	1139	Lone Pine Ck. - ExxonMobil	26.6	9.9	6.2	11.1	67.8	77.7	83.9	95.1	
14	1047	Minnehik B. L. - Penn West	13.4	9.7	3.3	3.0	22.8	32.6	35.9	38.9	
15	1530	Okotoks - Mazeppa Processing	-	-	-	-	-	-	-	-	Degrandfathered
16	1028	Redwater - Imperial	-	-	-	-	-	-	-	-	Variable inlet rate
17	1206	Rosevear (North) - Suncor*	-	-	-	-	-	-	-	-	Plant shut down
18	1268	Rosevear (South) - Suncor*	114.2	111.1	122.4	99.7	601.0	712.1	834.5	934.2	
19	1113	Simonette - Suncor	96.0	83.4	79.3	55.1	259.2	342.6	421.9	477.0	
20	1141	Strachan (Ram River) - Husky	1,698.8	1,468.2	1,605.6	1,860.7	8,150.1	9,618.3	11,223.9	13,084.6	
21	1133	Strachan - KeySpan	64.2	68.7	45.0	102.1	485.8	554.6	599.5	701.6	
22	1112	Sturgeon Lk. - Chariot	61.4	69.1	53.2	73.5	229.9	299.0	352.2	425.7	
23	1296	Teepee - Talisman	44.2	51.1	45.9	49.1	157.4	208.4	254.3	303.4	
24	1056	Waterton - Shell	281.8	414.8	300.2	295.5	3,013.4	3,428.2	3,728.4	4,023.9	
25	1054	Wildcat Hills - Petro-Canada	112.4	96.2	97.8	97.7	699.5	795.7	893.5	991.2	
26	1081	Wimborne - Devon	81.5	10.1	85.8	100.5	765.4	775.5	861.3	961.7	
27	1034	Windfall (West Whitecourt) - BP Canada	245.1	264.1	190.5	254.4	1,983.1	2,247.2	2,437.7	2,692.1	
28	1219	Zama - Apache	109.5	114.9	66.8	43.5	517.0	631.9	698.7	742.2	
		Totals	4,029.49	3,182.30	3,635.66	3,412.86	22,402.8	25,585.1	29,220.8	32,633.6	

Appendix 4.1. Gas Plants with Sulphur Recovery, Year 2003 minus Year 2000

	Plant Code	Field-Operator	Change in Production and Emissions Year 2003 minus Year 2000 2003-2000 S Production (t/y)	2003-2000 S Emission (t S/y)
Grandfathered Plants				
1	1034	Windfall (West Whitecourt) - BP Canada	(132,424.0)	(2,857.3)
2	1141	Strachan (Ram River) - Husky	(132,927.1)	(2,081.4)
3	1108	Brazeau R. - KeySpan	(35,158.5)	(1,901.3)
4	1037	Jumping Pound - Shell	(47,116.7)	(1,882.8)
5	1144	Kaybob S. 3 - Chevron	(50,745.7)	(958.3)
6	1107	Kaybob S. 1 & 2 - BP Canada	(101,956.4)	(868.6)
7	1084	Edson - Talisman	(30,446.4)	(518.2)
8	1206	Rosevear (North) - Suncor	(12,290.7)	(499.6)
9	1113	Simonette - Suncor	(13,660.6)	(481.6)
10	1133	Strachan - KeySpan	(38,319.0)	(311.2)
11	1081	Wimborne - Devon	(15,009.4)	(292.5)
12	1112	Sturgeon Lk. - Chariot	(5,845.4)	(201.8)
13	1104	Caroline (South) 4-20 - BP Canada	(712.6)	(122.4)
14	1047	Minnehik B. L. - Penn West	(2,748.3)	(117.4)
15	1020	Carstairs - Bonavista	(867.1)	(106.0)
16	1050	Crossfield (Balzac) - Nexen	(1,829.2)	(102.3)
17	1056	Waterton - Shell	(107,275.6)	(68.9)
18	1131	Burnt Timber - Shell	(7,923.5)	(68.3)
19	1374	Caroline (North) 1-11 - BP Canada	(736.3)	(47.3)
20	1129	Gold Creek - CNRL	(5,308.4)	(46.1)
21	1121	Brazeau R. (Nordegg) - KeySpan	(908.1)	(30.1)
22	1219	Zama - Apache	(3,698.3)	(29.3)
23	1296	Teepee - Talisman	1,661.0	(22.0)
24	1530	Okotoks (Mazeppa) - Mazeppa Processing	(9,452.6)	(9.3)
25	1028	Redwater - Imperial	(161.7)	(4.9)
26	1054	Wildcat Hills - Petro-Canada	2,636.1	111.9
27	1268	Rosevear (South) - Suncor	4,680.7	143.3
28	1139	Lone Pine Ck. - ExxonMobil	2,588.4	158.0
	Totals		**(745,955.4)**	**(13,215.7)**
Grandfathered Plants That Were Previously Acid Gas Flaring and Are Now Sulphur Recovery				
1	1114	Bantry - Altagas	170.3	(94.1)
2	1096	Wilson Creek - Petro-Canada	590.4	(991.2)
Nongrandfathered Plants (Plants Meeting the Requirements for New Plants)				
1	1079	Crossfield E. - Primewest	(45,589.8)	(1,385.4)
2	1105	Rainbow - Husky	(22,351.5)	(1,019.3)
3	1004	Homeglen Rimbey - KeySpan	(6,346.0)	(799.6)
4	1021	Garrington (Olds) - Esprit	10,465.0	(756.2)
5	1360	Basing (Hanlan Robb) - Petro-Canada	(40,923.8)	(663.7)
6	1662	Caroline - Shell	(91,466.0)	(288.9)
7	1002	Nevis - Duke Energy	803.2	(91.4)
8	1060	Harmattan - Solex	(5,002.2)	(85.5)
9	1506	Progress - Anadarko	1,467.9	(25.9)
10	1585	Hays - Anadarko	60.7	(22.6)
11	1638	Campbell-Namao (Carbondale) - Atco Midstream	(109.6)	(0.2)
12	1629	Progress - Suncor	333.0	-
13	1658	Rainbow - Gibson	1,486.9	7.0
14	1045	Bonnie Glen - Imperial	1,460.8	29.1
15	1654	Swalwell - Viking	(109.6)	29.4
16	1458	Brazeau R. (West Pembina) - Atco Midstream	18,772.1	75.0
17	1147	Sinclair (Hythe Brainard) - EnCana	9,566.8	82.7
18	1051	Savanna Ck. (Coleman) - Northstar	8,408.8	208.6
19	1134	Quirk Ck. - Imperial	10,146.9	238.3
20	1892	Saddle Hills - EnCana	11,541.2	418.1
21	1482	Brazeau R. - Petro-Canada	39,025.2	510.6
	Totals		**(98,359.8)**	**(3,539.9)**
	Grand Totals		**(844,315.2)**	**(16,755.6)**

Appendix 4.2. Gas Plants with Sulphur Recovery, Year 2000

	Plant Code	Field-Operator	Total Inlet (t/y)	Total Annual Emissions (t S/y)	Actual Sulphur Recovery Effic. (%)	Current Required Sulphur Recovery Effic. (%)	Total Annual Production (t/y)
Grandfathered Plants							
1	1034	Windfall (West Whitecourt) - BP Canada	286,311.3	4,616.6	98.4%	98.3	292,237.0
2	1141	Strachan (Ram River) - Husky	791,052.9	7,877.7	99.0%	98.1	781,009.3
3	1108	Brazeau R. - KeySpan	36,697.0	2,152.6	94.2%	92.1	35,158.5
4	1037	Jumping Pound - Shell	161,744.1	5,509.7	96.6%	96.2	158,522.1
5	1144	Kaybob S. 3 - Chevron	360,565.8	6,646.1	98.2%	98.1	369,708.4
6	1107	Kaybob S. 1 & 2 - BP Canada	234,341.8	2,756.9	98.9%	98.4	250,134.3
7	1084	Edson - Talisman	73,009.3	1,421.2	98.1%	97.9	73,337.4
8	1206	Rosevear (North) - Suncor	10,771.6	499.6	96.1%	94.6	12,290.7
9	1113	Simonette - Suncor	32,358.2	793.8	97.5%	96.5	31,239.2
10	1133	Strachan - KeySpan	97,769.5	1,169.6	98.8%	98.1	97,129.6
11	1081	Wimborne - Devon	57,618.0	1,833.9	96.7%	95.5	54,008.0
12	1112	Sturgeon Lk. - Chariot	18,698.9	729.2	96.2%	94.0	18,456.1
13	1104	Caroline (South) 4-20 - BP Canada	2,483.7	349.5	86.2%	85.0	2,186.0
14	1047	Minnehik B. L. - Penn West	7,018.8	270.4	96.1%	95.6	6,748.4
15	1020	Carstairs - Bonavista	3,815.5	324.6	91.2%	90.0	3,370.0
16	1050	Crossfield (Balzac) - Nexen	144,323.2	2,408.8	98.3%	98.0	141,245.3
17	1056	Waterton - Shell	671,377.4	6,233.1	99.1%	98.7	679,224.2
18	1131	Burnt Timber - Shell	156,959.7	4,844.0	96.9%	96.5	152,115.5
19	1374	Caroline (North) 1-11 - BP Canada	1,039.2	86.8	91.2%	89.7	903.1
20	1129	Gold Creek - CNRL	20,071.4	514.9	97.6%	97.0	20,883.0
21	1121	Brazeau R. (Nordegg) - KeySpan	12,991.3	727.9	94.6%	93.5	12,842.1
22	1219	Zama - Apache	15,117.5	583.9	96.1%	92.0	14,405.1
23	1296	Teepee - Talisman	5,424.7	372.2	93.2%	92.0	5,070.9
24	1530	Okotoks (Mazeppa) - Mazeppa Processing	95,120.2	1,260.7	98.7%	98.3	95,760.9
25	1028	Redwater - Imperial	1,184.9	88.3	92.7%	Fluctuating	1,118.3
26	1054	Wildcat Hills - Petro-Canada	71,413.7	1,220.0	98.2%	97.5	66,931.2
27	1268	Rosevear (South) - Suncor	16,104.4	457.5	97.6%	95.6	18,426.7
28	1139	Lone Pine Ck. - ExxonMobil	38,390.2	599.7	98.4%	98.0	37,232.3
	Totals		**3,423,774.2**	**56,349.2**	**98.4%**		**3,431,693.7**
Grandfathered Plants That Were Previously Acid Gas Flaring and Are Now Sulphur Recovery							
1	1114	Bantry - Altagas	310.6	310.7	0.0%	-	-
2	1096	Wilson Creek - Petro-Canada	908.0	1,036.4	0.0%	-	-
Nongrandfathered Plants (Plants Meeting the Requirements for New Plants)							
1	1079	Crossfield E. - Primewest	170,668.1	3,028.6	98.2%	98.0	169,921.2
2	1105	Rainbow - Husky	25,910.0	1,123.5	95.2%	95.0	22,351.5
3	1004	Homeglen Rimbey - KeySpan	19,957.4	1,003.0	94.8%	92.0	18,208.7
4	1021	Garrington (Olds) - Esprit	103,220.0	2,152.2	97.9%	97.1	101,783.0
5	1360	Basing (Hanlan Robb) - Petro-Canada	299,824.2	3,434.8	98.8%	98.5	288,911.9
6	1662	Caroline - Shell	1,833,270.9	2,458.5	99.9%	99.8	1,844,827.3
7	1002	Nevis - Duke Energy	37,590.7	467.5	98.8%	98.4	37,091.8
8	1060	Harmattan - Solex	11,515.1	164.6	98.6%	98.6	11,875.6
9	1506	Progress - Anadarko	9,215.7	237.8	97.4%	96.5	9,060.8
10	1585	Hays - Anadarko	2,390.2	129.0	94.5%	90.0	2,217.5
11	1638	Campbell-Namao (Carbondale) - Alco Midstream	364.6	0.2	100.0%	69.7	403.7
12	1629	Progress - Suncor	389.1	-	100.0%	69.7	336.7
13	1658	Rainbow - Gibson	1,882.0	127.9	92.6%	70.0	1,597.4
14	1045	Bonnie Glen - Imperial	3,281.6	125.8	96.1%	95.9	3,062.0
15	1654	Swalwell - Viking Keywest	517.6	138.9	79.3%	70.0	533.4
16	1458	Brazeau R. (West Pembina) - Alco Midstream	107,983.1	1,624.1	98.6%	98.4	112,615.2
17	1147	Sinclair (Hythe Brainard) - EnCana	28,431.8	296.2	99.0%	98.3	28,291.8
18	1051	Savanna Ck. (Coleman) - Northstar	137,197.0	1,369.9	99.0%	98.6	136,352.7
19	1134	Quirk Ck. - Imperial	86,771.0	1,002.1	98.9%	98.3	90,372.6
20	1892	Saddle Hills - EnCana	125,906.9	1,292.3	99.0%	98.4	126,382.7
21	1482	Brazeau R. - Petro-Canada	97,601.0	917.1	99.1%	98.4	96,505.4
	Totals		**3,103,888.0**	**21,094.0**	**99.3%**		**3,102,702.9**
		Grand Totals	**6,527,662.2**	**77,443.2**	**98.8%**		**6,534,396.6**

Appendix 4.3. Gas Plants with Sulphur Recovery, Year 2003

	Plant Code	Field-Operator	Total Inlet (t/y)	Total Annual Emissions (t S/y)	Annual Sulphur Recovery (%)	Current Required Sulphur Recovery Effic. (%)	Total Actual Production (t/y)
Grandfathered Plants							
1	1034	Windfall (West Whitecourt) - BP Canada	159,304.1	1,759.3	98.9%	98.3	159,813.0
2	1141	Strachan (Ram River) - Husky	654,943.3	5,796.3	99.1%	98.1	648,082.2
3	1108	Brazeau R. - KeySpan	49,297.5	251.3	99.5%	92.1	Injected (49055.2)
4	1037	Jumping Pound - Shell	112,414.3	3,626.9	96.8%	96.2	111,405.4
5	1144	Kaybob S. 3 - Chevron	338,814.6	5,687.8	98.2%	98.1	318,962.7
6	1107	Kaybob S. 1 & 2 - BP Canada	150,523.7	1,888.3	98.7%	98.4	148,177.9
7	1084	Edson - Talisman	42,494.4	903.0	97.9%	97.9	42,891.1
8	1206	Rosevear (North) - Suncor	-	-	0.0%	0.0	-
9	1113	Simonette - Suncor	17,871.6	312.2	98.3%	96.5	17,578.6
10	1133	Strachan - KeySpan	60,316.4	858.4	98.6%	98.1	58,810.6
11	1081	Wimborne - Devon	39,820.7	1,541.4	96.2%	95.5	38,998.6
12	1112	Sturgeon Lk. - Paramount	12,951.3	527.4	96.0%	94.0	12,610.7
13	1104	Caroline (South) 4-20 - BP Canada	1,945.0	227.1	86.6%	85.0	1,473.4
14	1047	Minnehik B. L. - Penn West	4,186.8	153.0	96.3%	95.6	4,000.1
15	1020	Carstairs - Bonavista	2,733.1	218.6	92.0%	90.0	2,502.9
16	1050	Crossfield (Balzac) - Nexen	143,395.4	2,306.5	98.4%	98.0	139,416.1
17	1056	Waterton - Shell	577,000.0	6,164.2	98.9%	98.7	571,948.6
18	1131	Burnt Timber - Shell	144,635.7	4,775.7	96.8%	96.5	144,192.0
19	1374	Caroline (North) 1-11 - BP Canada	277.6	39.5	80.9%	69.7	166.8
20	1129	Gold Creek - CNRL	15,973.7	468.8	97.1%	97.0	15,574.6
21	1121	Brazeau R. (Nordegg) - KeySpan	12,582.3	697.8	94.5%	93.5	11,934.0
22	1219	Zama - Apache	11,398.1	554.6	95.1%	92.0	10,706.9
23	1296	Teepee - Talisman	7,107.6	350.2	95.1%	92.0	6,731.9
24	1530	Okotoks (Mazeppa) - Mazeppa Processing	81,605.3	1,251.4	98.6%	98.4	86,308.3
25	1028	Redwater - Imperial	1,008.5	83.4	92.0%	80.0	956.7
26	1054	Wildcat Hills - Petro-Canada	71,396.2	1,331.9	98.1%	97.5	69,567.3
27	1268	Rosevear (South) - Suncor	23,881.8	600.8	97.5%	95.6	23,107.4
28	1139	Lone Pine Ck. - ExxonMobil	40,627.1	757.7	98.1%	98.0	39,820.6
	Totals		**2,778,506.2**	**43,133.5**	**98.4%**		**2,685,738.3**
Grandfathered Plants That Were Previously Acid Gas Flaring and Are Now Sulphur Recovery							
1	1114	Bantry - Altagas	435.4	216.6	44.0%	70.0	170.3
2	1096	Wilson Creek - Petro-Canada	576.5	45.2	92.9%	85.0	590.4
Nongrandfathered Plants (Plants Meeting the Requirements for New Plants)							
1	1079	Crossfield E. - Primewest	126,853.1	1,643.2	98.7%	98.4	124,331.4
2	1105	Rainbow - Husky	37,611.6	104.2	99.7%	98.3	Injected (37619.0)
3	1004	Homeglen Rimbey - KeySpan	9,949.6	203.4	98.3%	98.3	11,862.7
4	1021	Garrington (Olds) - Esprit	113,568.0	1,396.0	98.8%	98.4	112,248.0
5	1360	Basing (Hanlan Robb) - Petro-Canada	250,472.1	2,771.1	98.9%	98.5	247,988.2
6	1662	Caroline - Shell	1,742,825.2	2,169.6	99.9%	99.5	1,753,361.3
7	1002	Nevis - Duke Energy	38,006.9	376.1	99.0%	98.4	37,895.0
8	1060	Harmattan - Solex	6,942.2	79.1	98.9%	98.6	6,873.4
9	1506	Progress - Anadarko	10,729.5	211.9	98.0%	96.5	10,528.7
10	1585	Hays - Anadarko	2,419.6	106.4	95.5%	90.0	2,278.2
11	1638	Campbell-Namao (Carbondale) - Atco Midstream	287.0	-	100.0%	69.7	294.1
12	1629	Progress - Suncor	688.6	-	100.0%	69.7	669.7
13	1658	Rainbow - Gibson	3,288.1	134.9	95.8%	89.7	3,084.3
14	1045	Bonnie Glen - Imperial	4,830.1	154.9	96.7%	95.9	4,522.8
15	1654	Swalwell - Viking	573.7	168.3	71.6%	70.0	423.8
16	1458	Brazeau R. (West Pembina) - Atco Midstream	128,781.5	1,699.1	98.7%	98.4	131,387.3
17	1147	Sinclair (Hythe Brainard) - EnCana	38,386.1	378.9	99.0%	98.3	37,858.6
18	1051	Savanna Ck. (Coleman) - Northstar	147,177.8	1,578.5	98.9%	98.6	144,761.5
19	1134	Quirk Ck. - Imperial	99,276.9	1,240.4	98.8%	98.3	100,519.5
20	1892	Saddle Hills - EnCana	142,733.2	1,710.4	98.8%	98.4	137,923.9
21	1482	Brazeau R. - Petro-Canada	133,572.1	1,427.7	99.0%	98.4	135,530.6
	Totals		**3,038,972.9**	**17,554.1**	**99.4%**		**3,004,343.1**
		Grand Totals	**5,817,479.0**	**60,687.6**	**98.9%**		**5,690,081.3**